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FIVE-YEAR WATER RESOURCES RESEARCH AND DEVELOPMENT PLAN

FISCAL YEARS 1982-1986

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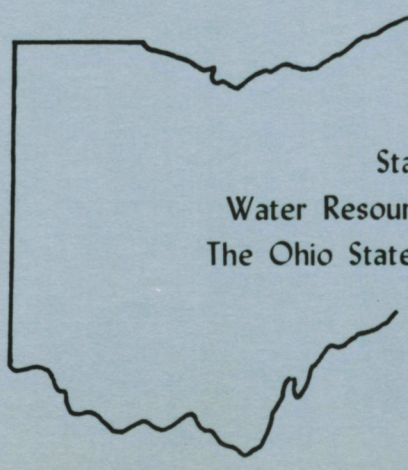
Office of
Water Research and Technology,
United States
Department of the Interior



State of Ohio
Water Resources Center
The Ohio State University

FIVE-YEAR WATER RESOURCES RESEARCH AND DEVELOPMENT PLAN
FISCAL YEARS 1982-1986

Submitted to

THE OFFICE OF WATER RESEARCH AND TECHNOLOGY
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SECTION I

SUMMARY

Water is one of Ohio's most important natural resources, and the state is fortunate that it has an abundance of ground and surface waters to meet its immediate needs. The annual precipitation in Ohio provides, on the average, over 25 billion gallons of water a day; and there is the equivalent of another 150 billion gallons of water available each day in the Ohio River and in Lake Erie.

Water withdrawn from the ground and surface sources in the state during 1975 amounted to 16 billion gallons per day. Most of this water was returned to the streams and lakes for possible reuse, and only one-half billion gallons per day were actually consumed.

The largest use made of Ohio's water is to provide cooling at themo-electric power plants. In 1975, around 12 billion gallons of water were withdrawn from the resource each day to meet this demand. Since growth in electrical power generation and in the production of synthetic fuels from coal is anticipated, the mode of cooling used in these facilities will strongly influence the trends of water use in the future.

Surface water is the principal source of supply for most municipalities in the state, but ground water is used to supply most of the rural needs. Flooding is still a major water problem throughout the state and there are localized water shortages during low flow periods and during extended droughts

Most of Ohio's water related problems are associated with water quality. The combination of heavily industrialized urban areas, hundreds of small rural communities, and extensive agricultural and mining activities result in

the production of large quantities of waste products from both point and diffuse sources. Of particular concern are the sediments, nutrients, acids, and toxic organic and inorganic substances that appear in the surface runoff from urban, agricultural and mining areas throughout the state.

The potential contamination of the ground waters of the state from the improper disposal of toxic and hazardous wastes on the land surfaces is one of the more critical water resources problems that must be addressed at this time.

Other major water-related problems in Ohio include: the assessment of the impacts that water development projects will have on wetlands and on recreational activities; the quantification of the instream flow needs to maintain a diversity of species of aquatic organisms in the streams; and, a measure of the impacts caused by acid precipitation on the water quality in the state's streams and lakes.

The types of research needed to provide information to the decision-makers for the solution of the state's water problems are included in this report. Since it would be neither prudent nor desirable for the Water Resources Center to direct its limited resources toward the solution of all aspects of all of these problems, the research and development plan for the Center will be directed at supporting projects of a more limited design to supplement, enhance or extend the work of the larger, mission-oriented state and federal agencies that are conducting research in each of these problem areas.

Funds provided to the Center through the Annual Cooperative Program by the Office of Water Research and Technology will be directed at research needs associated with the state's water resources problems identified in this report, but Matching Fund Program monies will be used principally to help solve problems in the state that are either regional or national in scope.

This research and development plan for the Water Resources Center was prepared under the direction of the Office of Water Research and Technology in the U.S. Department of the Interior. The proposed allocation of federal funds provided by OWRT and of the cost-sharing monies required for this program are to be considered only in a broad context to demonstrate the emphasis that need be given to the research needs that have been identified. Actual funds allocated to a individual project will depend upon the scope of work to be accomplished.

SECTION II

OHIO'S WATER RESOURCES

Water is one of Ohio's most important natural resources Bounded on the north by Lake Erie and on the south by the Ohio River and containing other extensive ground and surface waters, Ohio has an adequate supply of water to meet its immediate needs. However, the combination of large, heavily industrialized urban centers; extensive agricultural activities; high volume coal production and large coal reserves; and the associated demands for new energy production continues to cause concerns related to water quality and water management. In addition, extreme hydrologic events cause localized problems of both excessive water and water deficiencies at times.

Precipitation

Ohio's precipitation, falling as rain, snow, sleet and hail, averages 38 inches annually. This precipitation is fairly evenly distributed over the state, being only slightly greater in the southern portions (44 inches per year) and diminishing toward Lake Erie in the north (32 inches per year). Figure II-1 shows the variation in annual precipitation across the state. Year-by-year averages of precipitation have wider fluctuations, however, and have ranged between a minimum of 26 inches and a maximum of over 50 inches.

Only a fraction of Ohio's precipitation remains available as a water resource. Large amounts of water are returned to the atmosphere each year as evaporation and through the release of moisture from vegetation (transpiration) These two processes - known collectively as evapotranspiration -

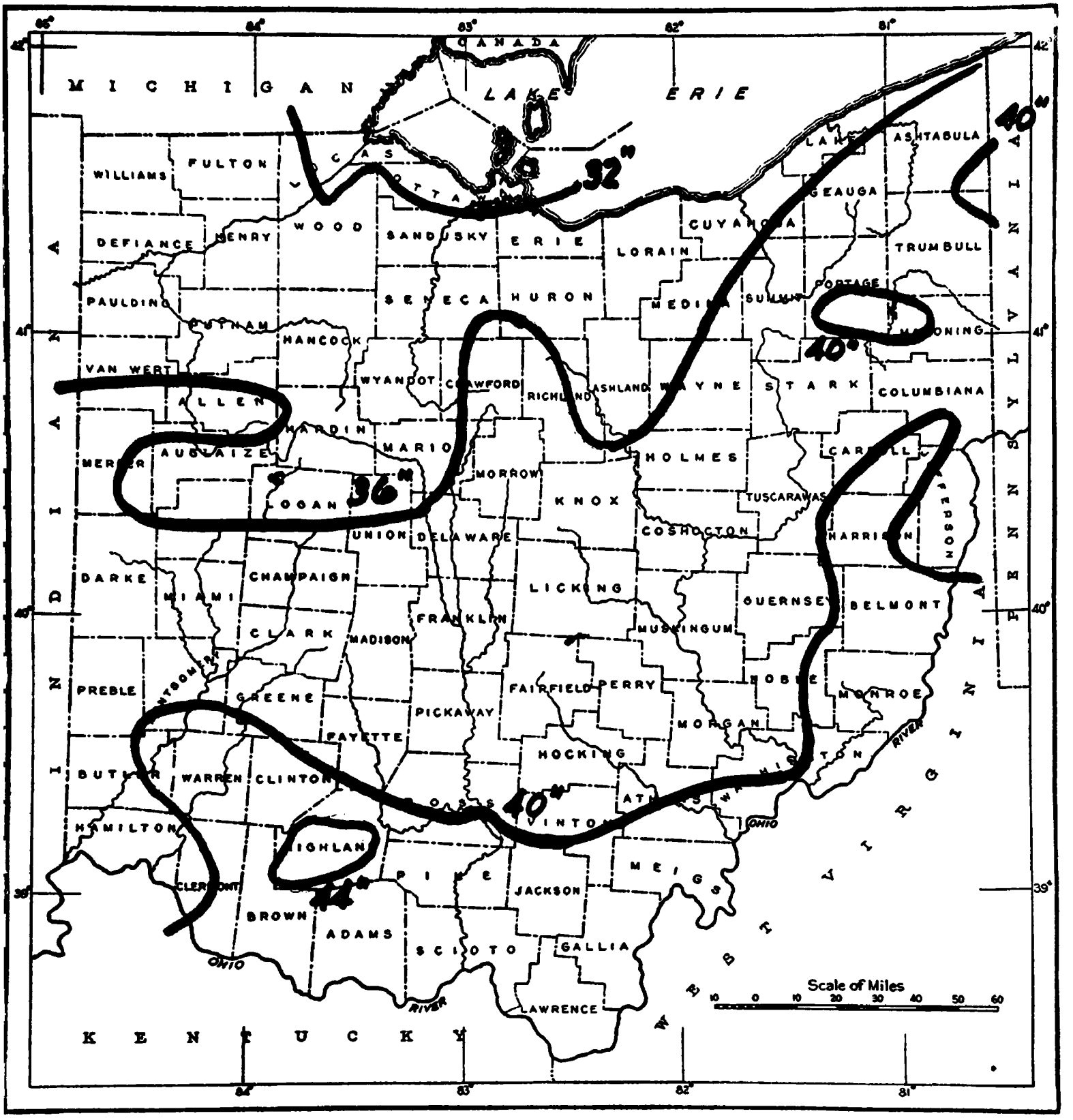


FIGURE II-1. VARIATIONS IN ANNUAL PRECIPITATION IN OHIO

remove on the average about 25 inches of water annually. The remaining 12 to 13 inches of water replenishes the ground water and provides the stream flow within the state.

Surface Waters

Ohio contains 23 principal surface drainage basins (Figure II-2). The northern 25 percent of the state's area drains into Lake Erie, while the southern portion drains into the Ohio River. Runoff from Ohio's streams and rivers averages around 12 inches per year or about 25 billion gallons per day. The annual runoff ranges from a value of 10 inches in the northwest portion of the state to about 18 inches in the southwest. The state also receives the equivalent of nearly one inch of runoff annually which drains through the Maumee River to Lake Erie from the neighboring state of Indiana. Ohio also has access to additional flows past its boundaries in Lake Erie and the Ohio River that total well over 150 billion gallons of water per day.

In 1975, slightly over 15 billion gallons of water were withdrawn from Ohio's surface sources each day to meet the demands for municipal supplies; rural needs for domestic and livestock purposes; irrigation; and self-supplied industrial needs including cooling water for thermo-electric power generation. These demands account for only 60 percent of the available surface waters in the state's streams each day, and localized shortages only develop during certain dry seasons and periodic droughts.

The combined length of all the streams in Ohio approaches 44,000 miles, which means that there is approximately one mile of stream for each square mile of surface area in the state. In addition, there are more than 50,000 lakes, ponds and reservoirs within the state having a combined surface area of 200,000 acres. Only a small fraction of these, about

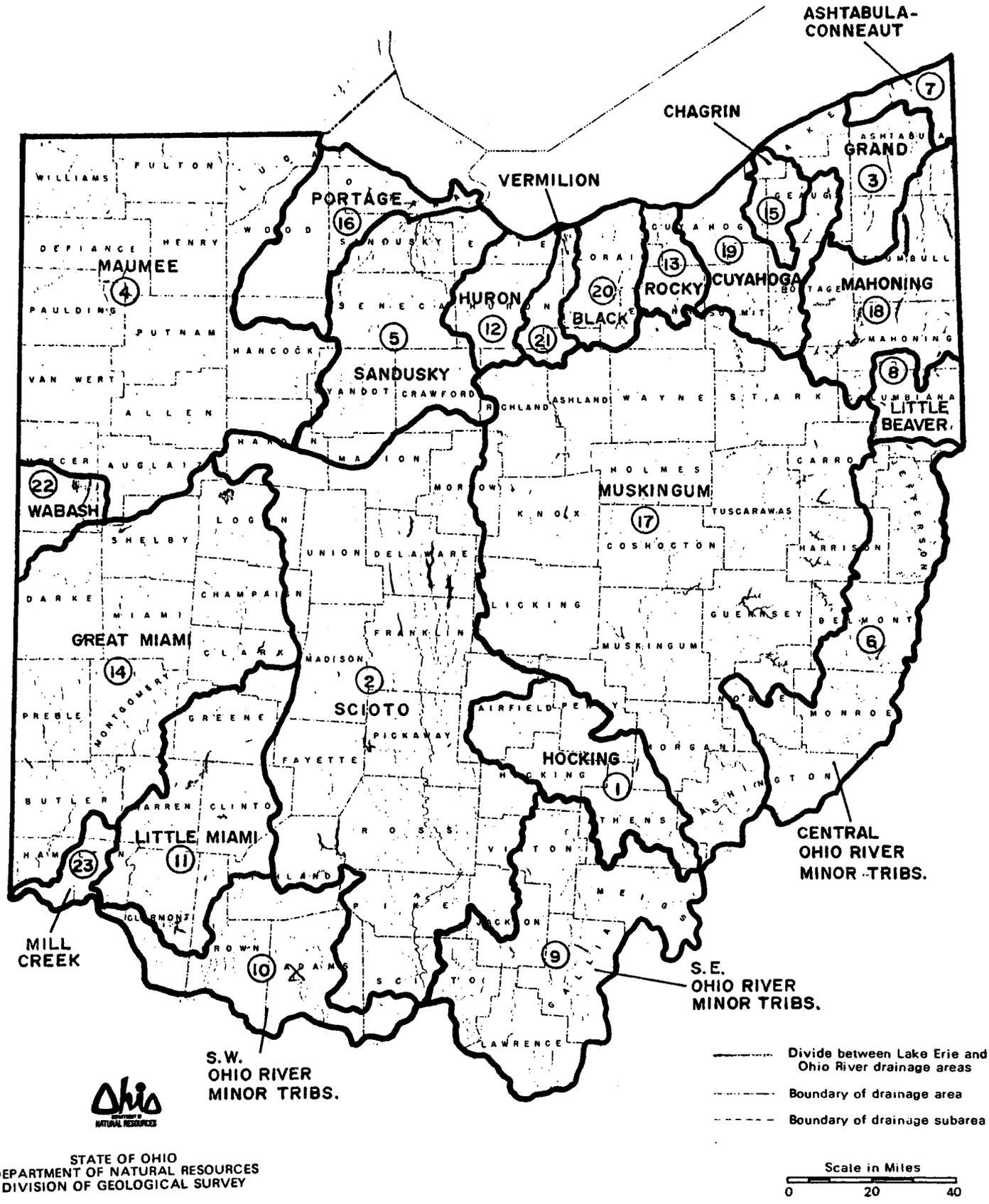


Figure II-2. PRINCIPAL STREAMS AND THEIR DRAINAGE AREAS

6,700 acres, occur naturally. The remainder are man-made impoundments that range in size from small farm ponds to large multipurpose reservoirs.

The reservoirs in the state have been built by federal agencies, state agencies, conservancy districts, municipalities, other governmental units and private industries. They are used to provide water for many different purposes including municipal, agricultural and industrial supplies; stream flow augmentation; flood control; and recreation. No impoundments in Ohio, other than those on the main stem of the Ohio River, provide water for downstream navigation or hydro-electric power generation. However, there is extensive navigation on both Lake Erie and the Ohio River, and consideration is being given to the installation of low-head hydro-electric generators at several developed dam sites throughout the state.

Flooding, still a major problem in Ohio, affects both urban and agricultural areas. Urban flood damages continue to grow because 1) detailed flood plain mapping for affected areas is not being provided at a rate fast enough to give municipal officials information they need to direct growth in these areas, 2) cities and counties continue to require assistance in developing and enacting ordinances to control land use activities in their flood plains, and 3) federal rules restrict the Corps of Engineers from providing flood protection in those drainage areas where the 10-year stream discharge is less than 800 cubic feet per second.

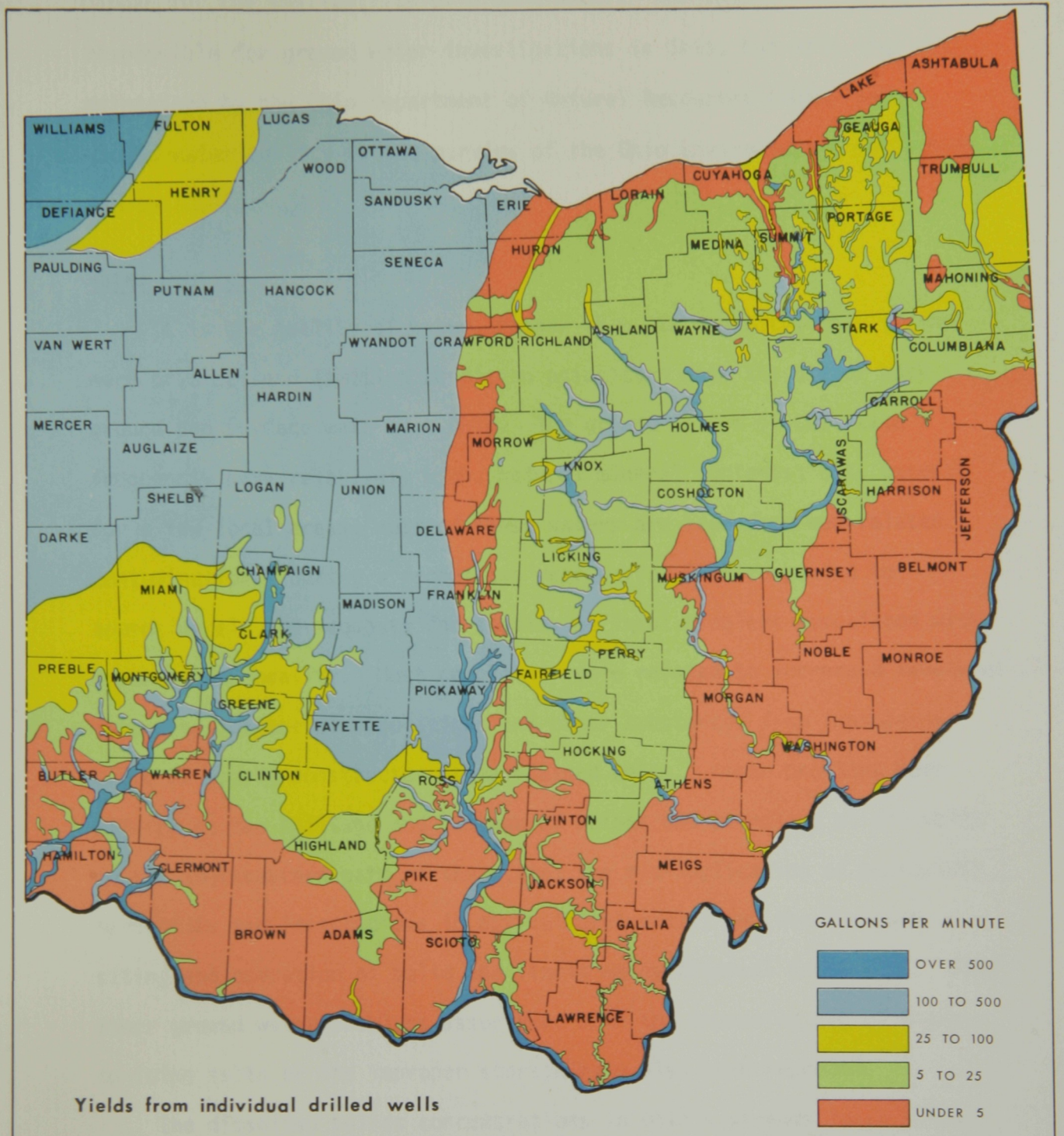
In 1975, the Soil Conservation Service estimated that nearly two million acres of land in Ohio were flood prone. This represents over seven percent of the total area of the state and includes nearly four percent of those areas classified as urban regions. Average annual flood damages in Ohio vary from year-to-year, but amount to millions of dollars annually. For example, flood damages in 1978 totaled between 30 and 40 million dollars.

Ground Water

Ground water is an important part of Ohio's water resources Ground water underlies most of the state but is predominate in the glacial drift in the northwest, in the ice-contact and outwash deposits in river valleys along the border of the glaciated areas, and in the bedrock of the western portions of the state. Ground water supplies are largest in the glacial valley-train deposits in those drainage basins which border the Ohio River including the Ohio, Miami, Little Miami, Scioto, Hocking and Muskingum Rivers. Well yields from these deposits often exceed 500 gallons per minute (gpm), while aquifers in the glacial drift in the northwest and west-central parts of the state produce yields between 100 and 500 gpm. Isolated aquifers in the northeast, northwest and southwest have yields between 25 and 100 gpm, while much of the northeast contains aquifers whose yield is between 5 and 25 gpm. With the exception of the valleys along the major streams, most of the aquifers in the area that is tributary to the Ohio River have yields less than 5 gpm. Figure II-3 shows the yields from individual drilled wells throughout the state.

Three-quarters of Ohio's 650 public water supply systems use ground water as their source. In terms of volume withdrawn, however, a lesser share of these supplies comes from ground water In 1975, 0.4 billion gallons of ground water was withdrawn each day for public water supply purposes, while over one billion gallons came from surface water sources. However, in the same year, ground water supplied nearly 80 percent of the rural water needs in Ohio, 32 percent of the irrigation waters and 21 percent of the industrial water demands. Nearly one billions qallons of ground water were withdrawn in the state each day to meet these needs.

Ground water investigations in Ohio have been underway since the first ground water report was published by the United States Geological Survey (USGS) in 1897. Ohio is one of the few states that has been completely



Yields from individual drilled wells

GROUND-WATER RESOURCES IN OHIO

OHIO DEPARTMENT OF NATURAL RESOURCES, DIVISION OF WATER

mapped for the availability of ground water The USGS is currently responsible for ground water investigations in Ohio, but well logs are maintained by the Ohio Department of Natural Resources (ODNR) and ground water quality is the purview of the Ohio Environmental Protection Agency (OEPA).

Water Quality

It is the quality of water, rather than its quantity, that is the more critical and limiting condition associated with the use of both ground and surface waters in Ohio. The ground waters of the state frequently have relatively high, natural mineral contents; but, except for a few local areas, most of these waters are free from man-related contamination. During a recent two year period OEPA responded to approximately 200 requests for studies on local problems associated with ground water quality. Most complaints were related to increased levels of turbidity, bacterial populations and other substances from improperly sited or poorly constructed or maintained wells. Other problems were related to the spillage and leakage of brines and petroleum at oil wells in the southeastern part of the state; the mis-application of pesticides, herbicides and insecticides in agricultural areas; and the improper siting and operation of solid and liquid waste disposal facilities. Some minor ground water problems associated with the excessive use of highway de-icing salts or its improper storage have also been reported.

The dissolved solids concentrations in Ohio's streams range between 120 and 2,500 milligrams per liter (mg/l). The higher concentrations are found in the Tuscarawas, Cuyahoga and Grand Rivers and in other stream reaches below major municipal and industrial outfalls or in areas subjected to diffuse source runoff

The Ohio Environmental Protection Agency has been monitoring 23,000

miles of the principal rivers downstream of major urban areas in the state, and has found that 1,600 miles, or 70 per cent of these streams, meet the current water quality standards. Where problems do exist, they are frequently caused by inadequate municipal wastewater treatment at facilities that need be upgraded or expanded, or by combined sewer overflows Substantial improvements in surface water quality have resulted from the development of pretreatment regulations for industrial waste discharges to municipal sewerage systems. Violations of the state's water quality standards occur most often in dissolved oxygen levels; ammonia nitrogen concentrations; the numbers of fecal coliforms; and the levels of heavy metals such as lead, zinc, and cadmium.

Acid mine drainage is a major cause of water quality problems throughout the Appalachian Coal Basin in the eastern United States. In Ohio this region extends in a band approximately 50 miles wide in a southwesterly direction from the east-central to the south-central parts of the state. Acid drainage from abandoned and improperly operated or reclaimed coal mined lands causes a loss of water for domestic and industrial uses; the degradation of water quality for recreational purposes; a lethal impact on the aquatic life in a stream; and, an accelerated deterioration of highway and railroad bridges and electrical transmission lines and towers. Drainage from abandoned coal mines, both surface and underground, has impacted around 1,500 miles of streams in 27 counties in southeastern Ohio. Approximately 370,000 acres of abandoned strip mines, 7,000 acres of coal refuse piles and 3,000 underground mines are contributing to this problem. It has been estimated that four billion dollars would be needed to reclaim the abandoned mines and refuse piles throughout Ohio. Projected revenues from severance taxes earmarked for abandoned mine reclamation come to about ten million dollars annually. Obviously, the technologic problems and the economic costs associated with the control of

acid mine drainage will continue to keep this a major problem of water quality in southeastern Ohio for years to come.

Little detailed information is available concerning the impacts that diffuse sources of pollution such as agricultural and urban stormwater drainage have on the quality of water in Ohio's inland streams. One concern with non-point pollution is the sediment that is dislodged from the land surface and carried to the streams. Of greater concern are the pollutants, such as the nutrients, heavy metals and toxic organic substances, that enter the streams attached to the sediments. No need for intensive, non-point source control programs to meet water quality standards in that area of the state that drains to the Ohio River has been shown; but several studies are underway in the Lake Erie drainage basin to define the role of agricultural drainage on the water quality in Lake Erie. Much more research and many more demonstration projects on the best management practices for agriculture, silviculture, mining and urban runoff control must be conducted before this problem is fully understood and control measures can be instituted.

The trophic status of several lakes and reservoirs has been studied by the OEPA. Results to date suggest that the lakes and reservoirs in the sandstone bedrock areas of the state have generally lower trophic levels than those in the limestone bedrock areas or glaciated regions. Water quality was generally good to excellent in most of the 71 lakes and reservoirs surveyed. However, excessive concentrations of copper and other heavy metals, bacteria and other pollutants normally associated with urban activities were identified in some of the lakes.

Lake Erie was said to be "dying" just a few years ago, but recent studies indicate that there has been a reduction in several key pollutants and a gradual, but steady, improvement in the water quality in the Lake. Phosphorus is a major pollutant which results in the excessive growth of

algae and other aquatic plants. As these plants die and decay, they deplete the oxygen resources of the Lake. The construction of facilities to remove phosphorus at those municipal wastewater treatment plants which discharge directly to Lake Erie has been a major factor in the reduction of phosphorus loadings and of the subsequent reduction of the anoxic areas within the Lake. Additional work on the control of phosphorus from both diffuse sources and point sources needs be accomplished, but a significant start has been made.

Levels of bacteria have been reduced in the nearshore zones where municipal wastewater treatment facilities have been constructed. This has permitted regulatory agencies to re-open bathing beaches which were often closed during the period between 1960 and 1970. Concentrations of mercury and pesticides have been reduced substantially, principally because of the federal bans that have been instituted on their manufacture, use and disposal. PCB remains a major challenge, as does the control of sediment and the nutrients, fertilizers and organic chemicals that are attached to it.

Fish populations, including the walleye pike, are beginning to increase again in the lake; but the quality and diversity of fish is still far from what they were in the past. Thermal pollution is a localized problem in some near-shore areas. However, as closed cycle cooling is required on all power generation facilities, the extent of this problem will diminish.

SECTION III

THE USE OF OHIO'S WATER RESOURCES

The most consistent set of data on the use of Ohio's ground and surface waters is presented in a series of reports entitled Estimated Use of Water in the United States which is prepared every five years by the United States Geological Survey (USGS) The most recent of these reports (1975) indicated that the total water withdrawals from both ground and surface water sources in Ohio amounted to around 16 billion gallons per day. Of this amount, slightly over one-half billion gallons were consumed each day.

The greatest use of the waters withdrawn in Ohio is made by thermo-electric power plants which collectively utilize nearly 12 billion gallons each day for cooling purposes. The remaining 25 percent of the withdrawals is divided among other users including self-supplied industrial plants, public water supplies, domestic and livestock needs in rural areas, and irrigation for agriculture.

Of the 506 million gallons of water consumed each day in 1975, the public supply sector used 210 million gallons; the industrial sector used 150 million gallons; and the rural and agricultural sector used 146 million gallons. Table III-1 summarizes both the water withdrawn and the water consumed in Ohio in 1975.

Water Use Projections

There are no state-prepared water use projections available for Ohio. The five water plans developed by the Division of Water in the Ohio Department of Natural Resources for different regions of the state do

TABLE III-1. AVERAGE DAILY WATER WITHDRAWN AND CONSUMED BY SECTOR AND SOURCE IN OHIO - 1975[a]

Sector	Water Withdrawn by Source						Water Consumed	
	Million Gallons			Percent by Sector			Million Gallons	Percent of Total
	Surface	Ground	Total	Surface	Ground	Total		
Thermo-Electric Power	12,000	23	12,023	80.3	2.2	75.1	78	15.4
Self-Supplied Industrial	1,900	500	2,400	12.7	47.9	15.0	72	14.2
Public Supplies	1,000	400	1,400	6.7	37.6	8.8	210	41.5
Rural (Total)	34	134	168	0.2	12.6	1.0	130	25.7
Domestic	(11)	(99)	(110)	(0.1)	(9.3)	(0.7)	(77)	(15.2)
Livestock	(23)	(35)	(58)	(0.2)	(3.3)	(0.4)	(54)	(10.7)
Agricultural Irrigation	13	6	19	0.1	0.6	0.1	16	3.2
Other Irrigation	--	--	--	--	--	--	79	--
Total[c]	14,900	1,100	16,000	100.0	100.0		506	100.0

a. USGS, Estimated Use of Water in the United States in 1975, Circular 765 (except other irrigation).

b. Division of Water. Ohio Department of Natural Resources.

c. Totals rounded to nearest 100 million gallons.

include projections for water demands for those communities included in the reports, but statewide water projections for all users have not yet been made a part of that planning process. In addition, projections based on the Division's 1970 inventory of water uses by planning regions are only now being prepared. Clearly the State of Ohio needs a uniform, updated set of water projections to help guide its future planning, development and research activities.

In the absence of any state projections, the Water Resources Center has prepared a set of water use forecasts specifically for this five-year plan of research and development. These forecasts were made by extending the USGS data for water withdrawals and consumption in Ohio in 1975 in proportion to the projections of water use made for the Great Lakes Region and the Ohio River Region that were developed by the Water Resources Council and included in Table II-4, Volume 3 of the Second National Assessment of the Nation's Water Resources. The results of these forecasts for the years 1985 and 2000 are shown in Table III-2. Since these forecasts are predicated upon the projections made in the Second National Assessment, it follows that the same rationalizations used in those documents to explain the projections of water withdrawal and consumption must also be used in this report.

The total amount of water withdrawn in Ohio is forecasted to decrease significantly between now and the year 2000. This decrease is anticipated to be the result of institutional and technological changes in the use of water for thermo-electric power generation and for self-supplied industries. The decrease in withdrawals for the thermo-electric power industry will result principally from advances in the technology for cooling water and by the uses of devices such as dry cooling towers. Because of limitations on allowable pollution discharges, the self-supplied industries are expected to develop a ten-fold increase in in-plant recycling, and to employ more

TABLE III-2. AVERAGE DAILY WATER WITHDRAWN AND CONSUMED BY SECTOR IN OHIO - PROJECTIONS FOR 1985 AND 2000

Sector	Water Withdrawn						Water Consumed					
	1975		1985		2000		1975		1985		2000	
	Million Gallons	Percent of Total	Million Gallons	Percent of Total	Million Gallons	Percent of Total	Million Gallons	Percent of Total	Million Gallons	Percent of Total	Million Gallons	Percent of Total
Thermo-Electric Power	12,023	75.1	11,575	82.3	7,055	73.9	78	15.4	180	27.1	480	46.1
Self-Supplied Industry	2,400	15.0	739	5.3	514	5.4	72	14.2	88	13.3	119	11.4
Public Supplies	1,400	8.8	1,545	11.0	1,748	18.3	210	41.5	231	34.8	263	25.3
Rural (Total)	168	1.0	185	1.3	193	2.0	130	25.7	141	21.2	146	14.0
Domestic	(110)	(0.7)	(122)	(0.9)	(126)	(1.3)	(77)	(15.2)	(84)	(12.7)	(85)	(8.2)
Livestock	(58)	(0.4)	(62)	(0.4)	(66)	(0.7)	(54)	(10.7)	(58)	(8.7)	(62)	(6.0)
Agricultural Irrigation	19	0.1	28	0.2	37	0.4	16	3.2	24	3.6	33	3.2
Total	16,000	100.0	14,072	100.0	9,547	100.0	506	100.0	664	100.0	1,041	100.0

processes and equipment that require less water.

While these two major water users are expected to withdraw less water than they did in 1975, their consumption of water is expected to increase in the future. The thermo-electric plants will utilize more closed-cycle cooling systems which withdraw less water but consume more. Similarly, recycling and reuse technologies expected to come on line in several manufacturing industries will require less water to be withdrawn but will also return less water to the source.

Withdrawals for irrigation needs, rural water uses and public water supplies will continue to increase moderately as they have during the last decade. Furthermore, total water consumption for these sectors will also continue to increase at, or about, the same rate as it has in the past.

Withdrawal Uses

Municipal Uses. In 1975, over 8.5 million people in Ohio were served by 650 public water supply systems. Over 1.4 billion gallons of water were withdrawn each day to meet these needs. Of this total, ground water was used to supply nearly 0.4 billion gallons of water to 2.75 million people, while surface sources supplied one billion gallons of water to over 5.75 million people. Thus, ground water use amounted to 28.6 percent of the total water withdrawn, but it served 32.2 percent of the population using public water supplies. In 1965, 24.5 percent of the water withdrawn for public supplies came from ground water sources and served 29.5 percent of the population. These figures indicate that there is an increasing dependence on ground water as a source of municipally supplied water in Ohio.

Per capita withdrawals of water for public supplies amounted to approximately 167 gallons per day in 1975, up from both the 157 gallons per day in 1970 and the 142 gallons per day in 1965.

According to the forecasts included in this report, public water supplies are expected to withdraw 1.6 billion gallons per day in the year 1985 and 1.75 billion gallons per day in the year 2000. This represents about a one percent average annual increase in withdrawals.

Self-Supplied Manufacturing Uses. In 1975, self-supplied industrial uses other than thermo-electric power generation withdrew 2.4 billion gallons of water per day. Among these manufacturing withdrawals, 0.5 billion gallons (20.8 percent) were from ground water sources and 1.9 billion gallons (79.2 percent) were from surface waters. These values in 1965 were 8.5 percent from ground water and 91.5 percent from surface water Thus, there has been a shift in uses to ground water supplies for the self-supplied manufacturing sector

Future projections suggest that withdrawals by manufacturing plants will decrease significantly; for, in the year 2000, only 0.5 billion gallons of water per day will be withdrawn for these purposes. This represents an average annual decrease of approximately 3.5 percent.

Rural Uses and Agriculture Needs. Rural water use consists of both water for domestic purposes and water used for livestock. In 1975, 110 million gallons of water per day was withdrawn for domestic purposes and 58 million gallons was withdrawn for livestock purposes Ground water supplied 99 million gallons, or 60 percent, of the domestic needs. Corresponding values for ground water withdrawals in 1965 were 84 and 62 percent, demonstrating an increasing dependence by rural residents on Ohio's ground water resources.

The rural domestic withdraws of 110 million gallons of water per day served a population of approximately 2.1 million people for a per capita value of 52 gallons per day. This is less than one-third of the 167 gallons of water per day for the per capita consumption in areas

served by public water supply systems. Of course, water use in urban areas includes the supplies made for some manufacturing and commercial purposes; while rural domestic use includes some relatively low-intensity household uses.

Projections in this report for the year 2000 show rural uses increasing at a rate of around 0.6 percent per year to a value of 193 million gallons per day.

Agricultural water needs in Ohio include water supplied for irrigation and for spraying fruit trees to prevent frost damage. These are both highly consumptive uses, but they only occur for limited times during the year, and the need for this water varies from year-to-year.

Irrigation is the smallest user of water among all sectors in terms of both water withdrawn and water consumed. However, in certain localities in the state, such as Canton and Willard, irrigation of field vegetables has been estimated to approach 1,200 acre-feet per year or 4.3 million gallons per day during the summer growing season for nine of every ten years. This withdrawal is equivalent to the domestic needs of a city of 72,000 people. When related water needs for processing the crops produced are added to these values, it is seen that irrigation withdrawals can be of great significance in certain localities, particularly at times of drought.

In 1975, six million gallons of the 19 million gallons withdrawn for agricultural irrigation each day came from ground water sources. This amounted to 30.6 percent of the total water withdrawn, and shows an increase when compared to the 29.2 percent of the 13 million gallons of water withdrawn for irrigation purposes in 1965.

Irrigation water supplied for golf courses is not included in the USGS figures, but it has been estimated that 91 million gallons of water was used for these purposes throughout the state during the four month growing season in 1975.

Thermo-Electric Power and Synthetic Fuel Production. The greatest single use made of the water withdrawn for all purposes in Ohio during 1975 was to provide cooling water for thermo-electric power plants Over 12 billion gallons of water were withdrawn each day from surface water sources to supply these needs, while only 23 million gallons came from ground water sources

Improvements in the methods to cool water from thermo-electric plants to satisfy more stringent thermal effluent standards are expected to reduce water withdrawals to a value approaching seven billion gallons per day by the year 2000, a reduction of over two percent per year

The availability of relatively large amounts of water and the close proximity to large coal reserves make the main stem of the Ohio Rover a logical location for the continued development of fossil-fueled electric generating plants and coal conversion facilities. Nearly half of the existing electrical power generated in the Ohio River Basin is produced at plants along the Ohio River, and two pilot facilities for the conversion of coal to synthetic fuels are also situated there

Several recent studies have attempted to assess the impacts that projected energy demands and the proposed development of synthetic fuel processors will have on the quantity and quality of water in the Ohio River In preparing information for the 1975 National Water Assessment, the Federal Energy Regulatory Commission forecasted a 330 percent increase in electrical generating capacity along the River by the year 2000 and the development of synthetic fuel processes that could produce between 80,000 and 100,000 barrels of oil, and between 1.5 and 4 billion cubic feet of synthetic gas per day The Commission indicated that when met, these projections would increase water consumption along the River by between 2,500 and 3,600 cubic feet per second (1.6 and 2.3 billions of gallons per day (bgd))

When coupled with water consumption projections for municipal, industrial and agricultural uses, upwards of 6,700 cfs (4.3 bgd) could be consumed from

the main stem of the Ohio River by the year 2000. The impacts of this large a consumptive use would be most significant during dry periods when larger amounts of the instream flows are needed to assimilate waste products, maintain adequate dissolved oxygen levels and meet the more stringent requirements on allowable temperature increases in the river

The Ohio River Basin Commission, following reviews of the Federal Energy Regulatory Commission's report and the National Coal Utilization Assessment by the U.S. Department of Energy, has suggested several alternatives be considered to alleviate some of the impacts that extensive energy development and synthetic fuel production might have on quality and quantity of flow in the Ohio main stem. They have recommended that adequately sized and spaced once-through cooling be used at thermo-electric generating stations in lieu of highly consumptive, evapovative cooling towers; that productive uses be made of the waste heat generated at these facilities; that more efficient power and conversion plants be developed; and that the waste products generated by synthetic fuel plants be re-cycled through the process and that the discharge of liquid wastes from these facilities be prohibited.

However, in the Ohio River Basin Commission report on the Ohio main stem, the projected increase in the consumptive use for all purposes by the year 2000 was not viewed as a very serious problem. The Commission felt that the lock and dam system along the River would still maintain a quantity of water sufficient to provide an adequate cover and habitat for most aquatic species; that the projected low flows in the river system was still adequate to meet navigational needs; and that there would be sufficient flow for the assimilation of the projected waste loads to the River

Instream Flow Uses

Recreation. The use of Ohio's water and water-related land resources for recreational purposes is an important and growing activity throughout the state

Ohio's water-based recreational estate is a large and varied system which is comprised of 1) 7,000 miles of streams and rivers, of which some 450 miles are currently protected from undesirable development by the Ohio and the National Wild and Scenic Rivers Programs; 2) 57,000 acres of small water bodies, each less than 40 acres in size, which are used primarily for recreational activities associated with fish and wildlife; 3) around 70,000 acres of large lakes and reservoirs which are used primarily for boating, fishing and water-contact recreation; 4) 110,000 acres of wetlands; 5) over two million acres on the surface of Lake Erie; and 6) nearly 260 miles of Lake Erie shoreline. Multi-purpose water resources development projects undertaken by the Ohio Department of Natural Resources, the U.S. Army Corps of Engineers, the Miami and Muskingum Conservancy Districts, local groups who have made use of the small watershed program provided by Public Law 566, and other local entities have greatly increased the recreational value of these important resources. So too have the watershed protection programs provided through the management of State and National forest lands; and by local, state and federal agencies promoting soil conservation programs.

Ohio's water resources provide opportunities for the residents of the state to fish, boat, swim, water-ski, hunt, trap and to enjoy other recreational or aesthetic pursuits. The value of the recreational resource can be illustrated by the fact that the annual sales of fishing licenses in the state exceeds 975,000; that over 250,000 boating permits are sold each year; and that, in 1980, on the average weekend day during the summer recreational period, over 4.2 percent of the households in Ohio included at least one member who fished, 2.3 percent of the households were boating and 0.8 of the households included at least one member who canoed.

Commercial Fishing. The commercial fishery in Lake Erie has been in existance for nearly 200 years. Since 1930, the average catch from the Lake has

been around 50 million pounds per year, which is very nearly the average combined harvest from all the other Great Lakes The higher nutrient levels and the warmer temperatures of Lake Erie apparently account for the relatively large size of the commercial fishery that exists in the Lake. The productively of Lake Erie, measured as pounds of fish per acre per year, may well be near an all time high; and what has been lost in species diversity has been more than replaced by increased numbers of those species which find the current habitat quite suitable.

Navigation. The only navigable waterways in Ohio are the Ohio River and Lake Erie. The Ohio River, through a system of locks at dams built, operated and maintained by the Ohio River Division of the U.S. Army Corps of Engineers, is navigable along its entire length in Ohio. Over 170 million tons of bulk commodities such as coal, petroleum, construction aggregates and chemicals were moved on the river in 1975. This amounted to over half of the total intercity tonnage moved by all other modes of transportation within the Ohio River Basin. Improved channels locks and terminal facilities will be needed to accommodate the projected 276 million tons to be transported by barge on the Ohio River by the year 2000.

A study entitled The Mid-American Ports estimated that in 1979 over 65 million tons of materials were handled by the ports in Ohio that are located on the Ohio River This tonnage was projected to increase by more than 100 percent by the year 2000 when 135 million tons are forecasted to be received or shipped from these ports. To accommodate this projected increase, 19 additional terminals need be developed in Ohio at an estimated cost of 189 million dollars.

Over 340 million tons of materials were transported in the Great Lakes navigational system in 1970, and this value has been projected to double by the year 2000. To accommodate this level of activity, existing constraints at

the Welland Canal and at Sault St. Marie will have to be removed.

The existing port facilities along Lake Erie in Ohio currently handle about 81 million tons of materials such as coal, iron ore, limestone and grain. Major port facilities currently exist at Toledo, Cleveland, Conneaut, Ashtabula, Lorain, Sandusky, Fairport and Huron The Buffalo District Office of the U.S. Army Corps of Engineers is responsible for the construction, maintenance and improvements to the harbor facilities at these ports The Corps is presently studying the implications of a very large projected increment in the movement of coal through the Lake Erie ports in Ohio.

Fish and Wildlife. The instream flow needs for fish and wildlife are extremely difficult to quantify. Complexities are caused by the wide variety of needs for the fish, aquatic organisms and wildlife which depend upon the instream environment for their survival and reproduction. The types of information that need to be developed include: the impacts that variations in the duration, frequency and magnitude of the stream's flow have on each of these diverse specifies; the effects that both short-term and sustained levels of pollutants have on the organisms; the interactions that exist in the stream between the levels of flow and the different pollutants, and between the synergistic and antagonistic affects of the pollutants themselves; and the variations in flow and depth between different reaches of the same stream.

SECTION IV

WATER AND RELATED LAND PLANNING AND DEVELOPMENT ACTIVITIES

The Ohio Department of Natural Resources (ODNR) and the Ohio Environmental Protection Agency (OEPA) are the principal agencies which collectively have legislative mandates for planning, developing, protecting, regulating and enhancing the water resources of the state. The Ohio Department of Health (ODOH) has some regulatory powers associated with on-site waste disposal and water supplies for individual users. Most of the other state agencies have an interest in water-related activities, but their concern is most frequently directed at the utilization of water to benefit the development of some other service, product or resource.

The water resources planning and development activities currently being conducted in the state can be classified in terms of water quantity and water quality. In a broad sense, the respective missions of the ODNR and OEPA can also be considered to be oriented towards water quantity and quality; so a brief description of the programs for these agencies will provide a fairly detailed description of the significant planning and development activities in the state.

Following severe droughts in 1953 and 1954, the General Assembly directed the Division of Water of ODNR to prepare river basin reports which would inventory water resources and uses; identify potential reservoir sites; and explore matters such as the economics of water development and control, water quality, recreational aspects, floods and drainage. Regional water plans have now been completed for five major groups of

drainage basins that encompass the whole state. Each report is detailed to the level of project costs for a series of alternative solutions to local and regional water problems. The first of these reports is now about ten years old and now must be upgraded to reflect the changing needs of population growth; shifts in industrial activity; and the objectives, needs and concerns of citizens.

Other sections and units of the Division of Water have other responsibilities related to water planning and development. The Water Resources Development Section is concerned with water planning, flood plain planning and community water assistance.

The Water Planning Unit of this Section has the responsibility for developing and upgrading the five regional water plans for the state. It also cooperates with the local entities which are planning, constructing and operating small watershed projects for flood control and prevention which are administered by the Soil Conservation Service under P.L. 566 programs. The Unit provides the final state review of the plans for these projects and insures their coordination with state plans, policies and objectives. Seven of these projects have now been completed, six are under construction, two are planned and three others are being planned. Applications for 17 other projects have been prepared, but scare staff and fundings resources have delayed their processing.

The Unit also serves as the liaison to the 30 Conservancy Districts in the state. The Districts have the authority to design, construct and operate flood control facilities; regulate stream channels; reclaim or fill wet lands; provide irrigation; regulate and divert stream flows; supply domestic and industrial water; control erosion; and collect and dispose of sewage. By 1975, 24 of the Districts had completed construction on water resources projects and 6 others had developed plans for construction.

The Flood Plain Planning Unit of the Division of Water coordinates local, state and federal efforts to reduce flood-related losses in Ohio. This Unit coordinates its activities with the Federal Insurance Administration in HUD, the USGS, the Corps of Engineers, and the SCS. The Unit encourages the adoption of land use regulations to minimize the loss of life, damage to property, and the need for structural flood control measures by promoting flood plain uses with are compatible with limited flooding conditions. It provides assistance to communities wishing to participate in the National Flood Insurance Program and to those wishing to enact land use control regulations to limit flood plain usage.

The Community Water Assistance Unit of the Water Resources Development Section compiles data on municipal, industrial and private water uses The Unit has recently completed inventories of municipal water supply systems and of lakes with a surface area greater than five acres, and they have nearly completed an inventory of industrial water supplies These types of data are shared with the USGS for inclusion in their five-year estimates of water use in the nation.

The Division of Water in ODNR and the USGS are currently developing a more effective and coordinated program for collecting, storing, accessing and disseminating water use data.

The Water Inventory Section in the Division of Water Collects, interprets and disseminates information on the ground water resources in Ohio. From their collection of over 400,000 well logs, they are mapping the aquifers throughout the state by their anticipated yields. Generalized maps showing ground water yields for different aquifers are available for the entire state, but more detailed information on well yields in specific areas and the adequacy of the yields to meet forecasted levels of population and industrial growth are available only in a few well studied areas.

This more detailed type of information is provided through special studies conducted by the Section or by the Hydrologic Investigations Program of the USGS.

The Section responds to over 4,000 requests each year from potential ground water users who seek help in locating and developing ground water supplies, consturcting wells or providing treatment of the ground water

The Water Inventory Section measures the ground water levels in 87 observation wells and the USGS does the same in 44 other wells in a cooperative program in ground water level monitoring. No water quality measurements are included in this program.

The Division of Ground Water in the Office of Wastewater Pollution Control in OEPA provides some information of ground water quality The Division does not monitor a series of wells, but insteads acquires information on ground water quality by analyzing data it collects in response to specific requests for well test. Approximately 200 such requests were handled by the Division during the past two years.

Surface water conditions such as discharge and depth are measured at a network of monitoring stations operated by the Water Inventory Section of ODNR or by the Section in cooperation with the USGS. This network consists of 320 stream stations which are monitored daily or monthly and 32 lake or reservoir stations. Water quality is also measured at 180 of the stream or lake and reservoir stations and at 21 other surface water sources.

The office of Wastewater Pollution Control in the OEPA also conducts surface water quality monitoring activities at 163 fixed stations, most of which are located in problem areas and on selected principal streams having a drainage area of at least 100 square miles. This office also operates 30 biological monitoring sites and usually conducts six intensive surveys of water quality in selected rivers each year It monitors the water quality

in several lakes and reservoirs, and monitors effluent quality at a sample of municipal and industrial wastewater treatment plants to determine compliance with the National Pollution Discharge Elimination System (NPDES), permits, to validate self-monitoring reports, and to provide support for enforcement actions.

The regionwide process of planning the Best Management Practices (BMP's) for the solution of non-point and point source pollution problems on an integrated basis with local input has been a mojor effort of the OEPA for over five years. These river basin Water Quality Management Plans, which are required by Sections 303 and 208 of the Clean Water Act of 1972 (P L. 92-500), are being developed for the whole state by the office of the Planning Coordinator, OEPA, and represent a continuation of planning efforts which the state has engaged in for many years. These water quality management plans complement the regional water plans of ODNR.

Water Quality Management Plans have been prepared for six "designated" areas of the state where established regional planning and management agencies were designated by the Governor to conduct the planning with guidance from the OEPA. Later, the office of the Planning Coordinator in OEPA became the lead agency for the development of the Section 208 plans under P.L. 92-500 for all areas of the state not previously included in one of the "designated" areas.

In 1978, the Water Quality Management Plans of each of the "designated" areas were either partially or conditionally certified by the Governor The USEPA has now conditionally approved three of these plans and has conditionally certified the proposed management structure for four of them. Planning is still underway in all six areas.

Planning for the non-designated areas of the state has progressed far enough to describe the point source pollution problems in each river basin;

to define the causes of these problems; to suggest alternative solutions to the problems; and to define the costs and benefits for implementing each alternative. Information on the non-point pollution problems in each basin from agricultural, urban and mining sources is being developed; and in-depth studies on ground water problems and other areas of concern are currently planned.

Within the next five years, the plans from the "designated" and non-designated areas will be integrated to form a statewide planning and management strategy for pollution control It is now envisioned that the management structures that are developed in the state's plans will implement the pollution control strategies, but that the OEPA will retain the review and certification functions, for it has the legal responsibility to meet the provisions of the Water Pollution Control Act.

There are many other water and related land planning and development activities being carried out in Ohio. Those being conducted by federal or quasi-federal agencies are generally coordinated through one of the principal water-related state agencies, and are therefore included in the major planning and management programs of these agencies However, the summary of the programs that have been described should give some indication of the magnitude of the efforts being conducted in water planning and management in Ohio.

SECTION V

OHIO'S WATER RESOURCES PROBLEMS

The development of this five year plan of research for the Water Resources Center required the acquistion, review and synthesis of published reports of the activities, programs and goals of international, federal, regional and Ohio agencies involved in the various aspects of water resources planning, development, regulation and use. Numerous interviews were conducted with key personnel in most of these agencies to develop their perceptions of the prioritization of these problems and the identification of the research needs in specific problem areas. Additional input has been received from members of the Center's Advisory Committees.

This categorization of Ohio's water resources problems has been prepared on the basis of the functional use of the resource. It attempts to focus on the conceptualization of those problems which exist principally because attributes of the resource itself are influencing the use of the water or the use of a related land resource.

Several methodologies of classifying the water resources problems of Ohio were examined before this particular technique was developed. For several reasons, however, it was decided that the purposes of this study could best be served by adopting this functional use approach.

Most of these problems were identified in earlier sections of this document. They are briefly summarized and then ranked according to the information provided by the leading water-related officials in the state. All of the problems defined are related to water quantity, water quality, water allocation or water-related land use.

No categorization has been made of problems with respect to the administration and management of governmental programs which affect water resources use along these functional lines. Those problems involved in the planning, administration and management of the state's water resources, and which are frequently lumped together under a heading of "institutional problems", have not been overlooked or neglected. Rather they are treated as institutional research needs with respect to all or most of the functional use problem areas and are included in a separate category of applied research needs in the next section of this report.

Water Quantity Problems

As noted previously, Ohio has an adequate supply of water to meet its immediate needs. However, both flooding and poor drainage, and the adverse economic impacts associated with them make the control of excess water one of the major water quantity problems in the state.

The need to conserve water and to develop contingency plans for allocating water resources during drought periods is a problem of some concern in the state, but one whose immediacy will probably not be evident until an extented drought actually occurs.

Problems with supplying the demands for water for certain specific uses or at particular locations within the state are beginning to emerge. Instream flow needs of aquatic organisms and plants in surface waters where the transport and assimilation of waste products are important adds a dimension to low flow problems that is related extensively to water quantity. In addition, water supplies of sufficient quantity and quality will be more difficult to obtain unless measures are instituted to remove greater concentrations of contaminants from surface and ground waters supplies and at wastewater treatment facilities. Water quantity problems related to recreational uses are expected to increase as Ohioans demand more nearby

recreational areas and water development projects to compensate for a lack of mobility caused by higher gasoline prices.

The proposed development of synthetic fuel processing plants and increased agricultural biomass production will result in localized problems in meeting the water demands for these high water consumptive uses.

Water Quality Problems

Synthetic fuel processing plants could also pose water quality problems since their effluents are expected to contain toxic substances, non-degradable contaminants and waste heat in quantities that are sufficient to exceed the state's water quality standards In addition, more progress needs to be made on the reduction of pollutants at the more conventional municipal and industrial wastewater treatment plants before point source discharges are no longer a problem in Ohio.

The findings of several studies and the results of water quality monitoring endeavors in many areas of Ohio point to the fact that extensive damages are being caused throughout Ohio and in Lake Erie by pollutants in the diffuse runoff from urban, agricultural and mining areas. The widespread impacts that result from these diffuse sources will continue to cause this problem to be an important one in Ohio, and one that needs be researched much more intensively.

The potential for the creation of water quality problems from the improper disposal of toxic, hazardous and solid wastes and from acid precipitation is of great concern in Ohio. These problems are national in scope, and they are being addressed at that level by the larger mission oriented agencies of the federal government. However, many of the impacts from the disposal of these substances are site specific, and the research needed to overcome some of these impacts can often be accomplished more expeditiously at the state level Furthermore, the impacts associated with

the disposal of toxic wastes can often be alleviated by controlling or removing the contaminants at their source so the effluent can be reused. Thus the development of improved technologies for the treatment of point source wastes is a research need in Ohio.

Water Allocation Problems

The allocation of water resources among competing users is not a major problem in Ohio at this time. However, alternatives are now being developed to alleviate the local water supply deficits that have been forecasted for some Ohio towns; and questions are being raised concerning the allocation of water from water supply and multi-purpose reservoirs throughout the state during times of drought or other emergencies. These potential problems are related in many ways to the problem of developing contingency plans for droughts.

Water Related Land Use Problems

Land and water use in heavily populated, industrialized and cultivated states such as Ohio are closely linked through many complex and interrelated threads of causes and effects. In their simplest form, these problems begin with the use of water and end with the disposal of waste products on the land surface. A more complex problem exists when one considers that the equivalent area of five counties in the state was converted from rural agricultural land to urban developed land during a recent ten year period. The impacts of water resource developments on the land resources in rapidly growing urban, suburban and other developed areas certainly ranks high as a problem area needing more investigation In this regard, the extension of water and sewer lines into these developing areas particularly deserves study possibly more than any other type of structural development.

The proposed construction of synfuel processors and other power, port or navigation facilities in the state will also lead to large impacts on the

land resources of the state and should be investigated more thoroughly. Developments in the flood plains or over ground water recharge areas and the disposal of municipal and industrial sludges and other wastes on the land surface pose some very real problems for Ohio.

Land related problems in the Lake Erie coastal zone include shore and beach erosion; loss of wetlands; and the need to provide navigational facilities, recreational facilities and energy production facilities in an already well developed area.

Priority Ranking of Ohio's Water Resources Problems

The major water resources problems in Ohio have been analyzed by several groups of water-related officials throughout the state. Based upon this analysis, the following ranking of these problems was developed:

1. POLLUTION FROM DIFFUSE SOURCES - including agricultural runoff; urban runoff; runoff from on-site waste disposal systems; runoff from active, reclaimed or abandoned coal and strip mines.

2. CONTAMINATION OF DRINKING WATER SUPPLIES - including surface and ground waters for both urban and rural uses by diffuse and point sources, and by the disposal of toxic and hazardous wastes on the land.

3. TOXIC AND HAZARDOUS WASTE DISPOSAL - including their control, treatment, disposal and impact upon land, water and air resources.

4. POLLUTION FROM POINT SOURCES - including municipal and industrial sources not yet in compliance with their NPDES permits.

5. IMPACTS OF FLOODING AND DRAINAGE - including flood damages, the use of flood plains and alternative structural and non-structural means of controlling floods and reducing flood damages.

6. IMPACTS OF WATER RESOURCES DEVELOPMENTS - including the impacts on various land uses caused by structural and non-structural water resources developments such as the extension of water mains and sewers into rural areas; flood control projects; hydro-electric power generation; water-based recreation; etc.

7. INSTREAM FLOWS NEEDS - including interrelationships among water quality, water quantity and land use practices on the instream flow needs for fish,

wildlife, and recreation and the optimum development and protection of these instream uses.

8. IMPACTS OF SYNTHETIC FUEL DEVELOPMENT - including requirements for water and impacts of the disposal of wastes from these processes into waters and onto the land.

9. IMPACTS OF ATMOSPHERIC POLLUTION - including the effects of acid precipitation and atmospheric fallout on water quality and the environment.

10. ALLOCATION OF WATER RESOURCES - including the development of contingency plans for the allocation and conservation of limited water supplies among competing water users during periods of low stream flows.

SECTION VI

RESEARCH PRIORITIES OF THE WATER RESOURCES CENTER

The Water Resources Center at the Ohio State University was created in 1958 as a separate research arm of the Engineering College's Experiment Station, and was itself an outgrowth of the Waste Treatment Laboratory which has been in existence on the campus since 1947 In 1964, the University assigned the direction and coordination of multidisciplinary research in water resources to the Center Less than a year later the United States Congress passed the Water Resources Research Act (P.L. 88-379) which provided for the establishment of a water resources research institute in each state and territory "to promote a more adequate national program of water resources related research" The Center was designated the Water Resources Research Institute for Ohio in 1965 and has served in that capacity since that time.

In 1978, the Water Resources Center was re-designated the Water Research and Technology Institute for Ohio in accordance with the provisions of the newly enacted Water Research and Technology Act (P.L. 95-467). In this capacity the Center is a partner with the Office of Water Research and Technology (OWRT) in the U.S. Department of the Interior

The Water Resources Center consults and collaborates with the leading officials in the water-related agencies in the state to identify water resources problem areas, to define research needs, and to disseminate information and transfer the technology that has been developed at the Center. The Center also collaborates with the Institutes in the other states in the Great Lakes and Ohio River Basins to develop programs and conduct research on water resources problems of a regional nature.

It has participated in several workshops in the region which were attended by state and federal agency personnel, members of the academic research community and by representatives from all sectors of the water user community to define research needs and to develop programs to complement the work of the various federal, state and local agencies having water resources-related missions.

The goals of the Water Resources Center may be summarized as follows:

> To provide a center of expertise for the solution of water and associated land-use problems, and to serve as a repository of knowledge to be used in education, research, training, planning and community service.
>
> To serve public and private interests in matters related to the conservation; development and use of the state's water resources
>
> To provide training opportunities in higher education for the development of scientists and engineers to serve in the water resources field.
>
> To provide assistance to water resources planning and regulatory agencies at the federal, regional, state and local levels of government.
>
> To provide a mechanism for the dissemination of information and the transfer of developing technologies in the water resources field.

As more and more of these goals are achieved, the Center will continue to develop as a focal point for water resources in Ohio.

Organization of the Center

The Water Resources Center is a multidisciplinary research organization on the campus of the Ohio State University. In addition to the Director, who is appointed by the Dean of the College of Engineering, the Center is staffed by an administrative assistant, secretary, and graduate research associates. The Center does not maintain a permanent faculty; but, instead, considers members of the faculty from all departments at

the University as its research staff The Center has two advisory committees.

The University Advisory Committee. The University Advisory Committee is appointed by the President of the University. The Committee establishes the operating policies for the Center, provides advice and counsel to the Director, and serves as the final selection committee for research projects to be included in the Annual Cooperative Program. The membership includes representatives from nine academic departments and four colleges. Current members include:

Engineering Experiment Station
Robert C. Stiefel, Chairman; Director, Water Resources Center
James F Teeple, Secretary; Assistant to the Director, WRC

College of Engineering
Edwin E. Smith, Chemical Engineering
Vincent T Ricca, Civil Engineering
Steven I Gordon, City and Regional Planning

College of Biological Sciences
Robert M. Pfister, Microbiology
Robert F Carline, Leader, Ohio Cooperative Fisheries Unit
Charles E. Herdendorf, III; Director, Center for Lake Erie Area Research
David A. Culver, Zoology

College of Agriculture and Home Economics
Robert L. Vertrees, School of Natural Resources
Robert H. Miller, Agronomy
Glenn O. Schwab, Agricultural Engineering

College of Mathematics and Physical Sciences
Wayne A. Pettyjohn, Geology and Mineralogy

Student Members
Robert J. Risner, Department of Microbiology
Paul Schroeder, Department of Civil Engineering

The Statewide Advisory Committee. The Statewide Advisory Committee for the Water Resources Center establishes the long range goals for the Center and assists in identifying water resources problems in the state, describing research needs and in disseminating program results Members or other qualified people in the agencies they represent have also reviewed research proposals for the program. Members of the Committee were selected on the

basis of their knowledge and expertise in water resources and not because of their organizational affiliation. Current members include:

Mr. Steven Hindall, District Chief, U.S. Geological Survey

Mr. Herbert Eagon, Jr , Geologist, Moody & Associates

Dr. Jay H. Lehr, Executive Director, National Water Well Association

Mr. Robert C. Lewis, Retired General Manager, Southwestern Ohio Water Company

Mr. Lawrence C. Crawford, Vice-President, Agricultural Section, Water Management Association of Ohio

Mr. Robert Goettemoeller, Ohio Department of Natural Resources

Mr. William Black, Vice President, Ohio Power Company

Dr. George A. Watkins, Staff Sociologist, Battelle Memorial Institute

Ms. Christina Carlson, Environment Director, Ohio League of Women Voters

Dr. Ronald G. Schmidt, Professor, Department of Geology, Wright State University

Dr. William G. Mattox, Deputy for Water Planning and Policy, Ohio Department of Natural Resources

Mr. Earl Richards, former Assistant Director, Ohio Environmental Protection Agency

Mr. S.L. Frost, Member, Chio. Board of Environmental Review.

Mr. I Bernstein, Basin Planner, Ohio River Basin Commission

Research Needs

The identification of Ohio's water resources research needs was accomplished with the assistance of a very large number of people throughout the state who are active in the water field and are working in a water-related program.

Following an extensive review of the programs, studies, plans and reports of the federal, regional, state and local water-related agencies,

a matrix was prepared that compared the state's water reources problems against the functions that are served by water resources research. At the very broadest level, the functions served by research can be considered to be of either a basic or applied nature.

Basic research is needed to develop an understanding of the nature of the resources and the extent of those problems that are associated with man's use of water. Thus, basic research attempts to assess the potential health effects and the other impacts that the discharge of contaminants from human activities have on the environment and on the resource itself

Applied research is required to provide information that decision makers need to know about the water resources so they can establish alternative solutions for a problem and can choose the best of those alternatives. Inherent in this activity is the need to disseminate the information and to transfer the technologies that are developed during the research effort. Thus, applied research is concerned with such items as the development of data bases and planning methodologies; the identification and development of alternative solutions to water resources problems; and the provision of adequate information to assess the social, economic, health and environmental impacts that will be the result if any of these alternatives are implemented.

The matrix that was developed for these purposes is included as Table VI-1 of this report. This matrix was not circulated to those people in the state that assisted in defining Ohio's water research needs, but was used to guide the interviews that were conducted and to categorize the responses that were received. The matrix was then used to develop both the state's research needs and the Water Resources Center's priorities for conducting that research.

TABLE VI-1. WATER RESOURCES PROBLEMS VERSUS FUNCTIONS SERVED BY RESEARCH

PROBLEMS WITH THE FUNCTIONAL USE OF WATER RESOURCES (Intermediate Level of Classification)			FUNCTIONS SERVED BY WATER RESOURCES RESEARCH (Second Intermediate Level of Classification)																																	
			R1 Basic Research (Required to Understand the Nature and Extent of Problems with the Functional Use of Water Resources)												R2 Applied Research (Required during Various Stages of the Process of Arriving at Workable Solutions to Problems with the Functional Use of Water Resources)																						
			R1.a Water in Nature		R1.b Human Influences upon Water Resources						R1.c Influences upon Health of Organisms and Substances in Water				R2.a Develop Data Bases and Planning Methods			R2.b Identify and Develop Alternatives			R2.c Provide Information Required when Choosing among Alternatives and Implementing Chosen Alternatives							R2.d Transfer of Research Results			
			(1) The nature of water as a chemical compound	(2) The water cycle	(1) Effects on water resources of man's non-water activities	(2) Effects from meeting demands for specific or multiple uses	(3) Effects from controlling excess water	(4) Effects from conserving water	(5) Effects from pollutants	(6) Effects of pollution control techniques	(1) Transmitted in drinking water supplies	(2) Transmitted in food and beverages	(3) Transmitted when water resources are used for body-contact recreation	(4) Transmitted by insects and other animal vectors	(1) Design and operation of water resources data networks	(2) Development of general approaches to water resources planning	(3) Development of specific techniques of water resources planning	(1) Alternatives classified by types of functional problems addressed	(2) Structural alternatives (engineering works): detailed aspects	(3) Nonstructural alternatives: specific types	(1) Impacts of proposed or existing alternatives	(2) Acceptability of proposed or existing alternatives	(3) Operation and management of governmental projects	(4) Administration of governmental programs which implement nonstructural alternatives	(5) Coordination of governmental projects, programs, and agencies	(6) Coordination of the governmental and private sectors	(7) Meeting the manpower needs of government and the private sector	(1) Development of systems to further the understanding and implementation of scientific and technical information	(2) Transfer of technology through demonstration projects and other developmental activities
PI Water Quantity	PI.A	Meeting Demands for Specific Uses																																		
	PI.B	Controlling Excess Water and the Damages It Causes																																		
	PI.C	Conserving Water and Developing Contingency Plans for Droughts																																		
PII Water Quality	PII.A	Controlling Pollution from Point Sources																																		
	PII.B	Controlling Pollution from Diffuse Sources																																		
	PII.C	Controlling Pollution from Atmospheric Sources																																		
	PII.D	Controlling Pollution from the Transporting and Dumping of Hazardous, Toxic, or Solid Wastes																																		
PIII Allocating Water	PIII.A	Inter-Basin Transfers of Water Are Feasible																																		
	PIII.B	Inter-Basin Transfers or Water Are Not Feasible																																		
PIV Controlling Impacts upon Land Resources	PIV.A	Impacts upon Critical or Fragile Areas																																		
	PIV.B	Impacts from the Disposal of Dredged Materials																																		
	PIV.C	Impacts from the Disposal of Residuals from Wastewater Treatment																																		
	PIV.D	Impacts from the Construction and Operation of Structural Water Resource Developments																																		
	PIV.E	Impacts from Nonstructural Means of Managing Water Resources																																		

I. POLLUTION FROM DIFFUSE SOURCES

A. Agricultural Runoff

1. Assess impacts that increased pesticide usage required by "best management practices (BMP'S)" such as conservation tillage and no tillage have on agricultural runoff.

2. Assess impacts that BMP'S have on phosphorus and nitrogen levels in agricultural runoff

3. Model sediment transport processes and devise techniques of determining sediment delivery ratios.

4. Evaluate fertilizer management as a BMP

B. Mine Drainage

1. Need methodology developed to prioritize abandoned mines for acid drainage control programs.

2. Evaluate effectiveness of reclamation programs in reducting pollution to surface and ground water resources.

3. Research is needed to evaluate effectiveness of using other waste products to support vegetation and control acid seepage and runoff

C. Urban Runoff

1. Develop methodologies to control erosion and sediment transport in urban areas

D. On Site Disposal

1. Methods of improving on-site waste disposal systems in poor soils must be developed.

II. CONTAMINATION OF DRINKING WATER SUPPLIES

A. Surface Waters

1. Research is needed to develop methodologies to prohibit discharge of toxic substances to surface waters.

B. Ground Waters

1. Investigate fate of toxic and hazardous wastes in ground waters.

III. TOXIC AND HAZARDOUS WASTE DISPOSAL

A. Land Disposal

1. Determine criteria and inventory acceptable sites for disposal of toxic and hazardous wastes

2. Determine fate of toxic and hazardous waste materials discharged on land.

3. Develop program to educate public on need for safe, dependable waste disposal facilities.

B. Ground and Surface Waters

1. Evaluate impacts of toxic and hazardous waste disposal on water quality

2. Assess treatment potentials for water contaminated with toxic and hazardous wastes

IV POLLUTION FROM POINT SOURCES

1. Develop improved treatment schemes for municipal and industrial wastes.

2. Develop acceptable, low cost waste treatment technologies for small communities which cannot join regional facilities.

3. Evaluate institutional conflicts of jurisdictional boundaries in regulating point source discharges.

4. Research needed to compare marginal benefits from phosphorus removal in diffuse and point sources.

V IMPACTS OF FLOODING AND DRAINAGE

A. Flooding

1. Improve precision of modeling the effects of land use on flood magnitude and duration

2. Develop remote sensing techniques to assess potential flood damages.

3. Develop methodologies to regulate land use practices to reduce flood damages

B. Drainage

1. Determine fate of agricultural pollutants from tile drainage.

2. Evaluate need for stream channelization to effect agricultural drainage.

VI. IMPACTS OF WATER RESOURCES DEVELOPMENTS

1. Determine potential for recreational development along urban waterways.

2. Research is needed on methodologies for the analysis of secondary economic, social and environmental aspects associated with water resources developments.

3. Research is needed on the adequacy of enabling legislation at the local level to prohibit structures in flood plains.

4. Develop a pricing system for public water supplies that will promote conservation

5. Examine the delivery systems for supplying water and removing wastes from rural areas.

VII INSTREAM FLOW NEEDS

1. Determine quantitative relationships between stream flow, water quality and flow dependent users.

2. Develop improved methods for evaluating economic consequences of tradeoffs on instream uses.

3. Develop methodologies to define instream uses under a variety of circumstances.

VIII IMPACTS OF SYNTHETIC FUEL DEVELOPMENT

1. Study legal, economic, environmental and social problems associated with future energy conversion facility siting and development.

2. Develop techniques to minimize water consumption for energy conversion processes

3. Evaluate toxic effects of effluents from energy conversion processes on aquatic ecology.

IX. IMPACTS OF ATMOSPHERIC POLLUTION

1. Assess impacts of acid precipitation on surface and ground water quality and on terrestrial and aquatic ecosystems.

X. ALLOCATION OF WATER SUPPLIES

A. Droughts

1. Develop contingency plans for the allocation of water supplies among competing users during periods of drought.

B. Water Conservation

1 Assess water conservation associated with improved ground water recharge, improved management of multi-purpose reservoirs and other techniques.

2. Develop alternative methods of conserving water during droughts.

SECTION VII

THE CENTER'S FIVE-YEAR RESEARCH AND DEVELOPMENT PLAN

The Water Resources Center at the Ohio State University encourages and supports research that is directed at providing information needed to solve the major water problems at the local, state, regional and national levels. The research program at the Center includes basic or fundamental research, problem oriented or applied research, and information dissemination and technology transfer activities.

In addition to its role in conducting and support qualified water resources research, the Center plans to expand its efforts in several other program areas during the next five year period. Various departments and research units throughout the University and the state were surveyed for suggestions on how the operation of the Water Resources Center could be improved to better serve its function in the state and on the campus.

Based on the suggestions that were received, the Center will continue some of its current programs, revise others and initiate some new efforts

The Center plans to continue its operation of a water resources library to provide a source of reference material to student and faculty researchers and to personnel at the state and federal water agencies. It will also continue to disseminate the results of the research program to users throughout the state.

A program to sponsor at state-wide water resources conference will be re-established, and a series of workshops on developing technologies in water resources will be instituted. This program will differ in that the Center will now attempt to utilize existing extension personnel from other

programs in the state in the planning and conduct of these seminars and workshops. A campus-wide program in water resources will also be developed in which all of the water-related faculty at the Ohio State University can participate.

Through funds established as a memorial to Dr Kenesaw Shumate, a former Director of the Center, fellowships and awards to qualified students in water resources on the campus will be initiated in the spring of 1981.

The proposed research plan for the Center for the period between fiscal years 1982-1986 is shown in Tables VII-1 and VII-2. The estimated budget requirements are included in these tables for specified levels at program activity. The Office of Water Research and Technology (OWRT) has requested that these estimates be prepared based on (1) an annual cooperative program funding level of $115,000; (2) an annual cooperative program funding level of $250,000, and (3) a national matching grant program appropriation which is projected to increase from six million dollars to ten million dollars during the five year period.

OWRT has also requested that other sources of state and federal funds to conduct research that can be identified by the Center be budgeted in the same manner. Although the Center has had projects funded by other state and federal agencies and by private organizations, there are no long-term funds that can be budgeted for these purposes. Like many other Institutes, the Center does not have any direct appropriation from the state for its operations.

The priorities for the research programs at the Center can be determined principally from the dollar allocations of funds that have been proposed to conduct research in each area included in the following tables. While the Center will continue to urge the researchers in the state universities in Ohio to propose research in these problem areas, the Center must reserve the right to continue to review and fund other proposals that are responsive to providing information for the solution of all of Ohio's major water problems.

TABLE VII-1.
PROPOSED RESEARCH PLAN
ANNUAL COOPERATIVE PROGRAM FY 1982 - 1986
($115,000/year budget)

	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	Total
WATER RESOURCES CENTER'S PROGRAMS Program Development and Technology Transfer	45,000	48,000	50,000	53,000	55,000	251,000
I. POLLUTION FROM DIFFUSE SOURCES						
Agriculture Runoff			16,000			16,000
Mine Drainage						
Urban Runoff						
On-Site Disposal				11,000		11,000
II. CONTAMINATION OF DRINKING WATER						
Surface Water Sources			16,000			16,000
Ground Water Sources	14,000	15,000				29,000
III. TOXIC AND HAZARDOUS WASTE DISPOSAL						
Land Disposal	14,000	15,000				29,000
Ground and Surface Water				17,000		17,000
Siting	14,000	15,000				29,000
IV. POLLUTION FROM POINT SOURCES						
Municipal Sources	14,000				18,000	32,000
Industrial Sources						
Institutional Conflicts			16,000			16,000
Water Reuse						
V. IMPACTS OF FLOODING AND DRAINAGE						
Flooding				17,000		17,000
Drainage			17,000			17,000
VI. IMPACTS OF WATER RESOURCES DEVELOPMENTS						
Recreation					18,000	18,000
Wetlands						
VII. INSTREAM FLOW NEEDS						
Flow Requirements	14,000	15,000				29,000
Water Quality					18,000	18,000
VIII. IMPACTS OF SYNTHETIC FUEL DEVELOPMENTS						
Water Consumption				17,000		17,000
Water Quality						
IX. IMPACTS OF ATMOSPHERIC POLLUTION						
Acid Precipitation						
X. ALLOCATION OF WATER RESOURCES						
Droughts		7,000			6,000	13,000
Conservation						

PROPOSED RESEARCH PLAN
ANNUAL COOPERATIVE PROGRAM FY 1982 - 1986
($250,000/year budget)

	FY 1982	FY 1983	Fy 1984	Fy 1985	Fy 1986	Total
WATER RESOURCES CENTER'S PROGRAMS Program Development and Technology Transfer	65,000	67,000	70,000	72,000	75,000	349,000
I. POLLUTION FROM DIFFUSE SOURCES						
Agriculture Runoff	18,500	20,000	20,000			58,500
Mine Drainage	18,500	20,000				38,500
Urban Runoff				21,500	25,000	46,500
On-Site Disposal				6,000		6,000
II. CONTAMINATION OF DRINKING WATER						
Surface Water Sources			20,000	21,500	25,000	66,500
Ground Water Sources	18,500	20,000				38,500
III. TOXIC AND HAZARDOUS WASTE DISPOSAL						
Land Disposal	18,500	20,000				38,500
Ground and Surface Water		20,000		21,500		41,500
Siting	18,500	20,000				38,500
IV. POLLUTION FROM POINT SOURCES						
Municipal Sources	18,500		20,000	21,500	25,000	85,000
Industrial Sources				21,500		21,500
Institutional Conflicts			20,000			20,000
Water Reuse		20,000				20,000
V. IMPACTS OF FLOODING AND DRAINAGE						
Flooding				21,500	25,000	46,500
Drainage			20,000			20,000
VI. IMPACTS OF WATER RESOURCES DEVELOPMENTS						
Recreation			20,000			20,000
Wetlands					25,000	25,000
VII. INSTREAM FLOW NEEDS						
Flow Requirements	18,500	20,000				38,500
Water Quality		20,000	20,000	21,500	25,000	86,500
VIII. IMPACTS OF SYNTHETIC FUEL DEVELOPMENTS						
Water Consumption			20,000	21,500		41,500
Water Quality	18,500					18,500
IX. IMPACTS OF ATMOSPHERIC POLLUTION						
Acid Precipitation			20,000		25,000	45,000
X. ALLOCATION OF WATER RESOURCES						
Droughts	18,500	3,000				21,000
Conservation	18,500					18,500

TABLE VII-2.
PROPOSED RESEARCH PLAN
MATCHING GRANT PROGRAM FY 1982 - 1986
(OWRT'S budget from $6M to $10M)

	FY 1982	FY 1983	Fy 1984	Fy 1985	Fy 1986	Total
WATER RESOURCES CENTER'S PROGRAMS Program Development and Technology Transfer						
I. POLLUTION FROM DIFFUSE SOURCES						
Agriculture Runoff	30,000	30,000		34,000	35,000	129,000
Mine Drainage			32,000	34,000	35,000	101,000
Urban Runoff						
On-Site Disposal						
II. CONTAMINATION OF DRINKING WATER						
Surface Water Sources						
Ground Water Sources			32,000	34,000	35,000	101,000
III. TOXIC AND HAZARDOUS WASTE DISPOSAL						
Land Disposal						
Ground and Surface Water	30,000	32,000	32,000		35,000	129,000
Siting						
IV. POLLUTION FROM POINT SOURCES						
Municipal Sources						
Industrial Sources						
Institutional Conflicts						
Water Reuse	30,000	32,000	32,000			96,000
V. IMPACTS OF FLOODING AND DRAINAGE						
Flooding						
Drainage						
VI. IMPACTS OF WATER RESOURCES DEVELOPMENTS						
Recreation						
Wetlands	30,000	32,000				62,000
VII. INSTREAM FLOW NEEDS						
Flow Requirements						
Water Quality						
VIII. IMPACTS OF SYNTHETIC FUEL DEVELOPMENTS						
Water Consumption						
Water Quality			32,000	34,000	35,000	101,000
IX. IMPACTS OF ATMOSPHERIC POLLUTION						
Acid Precipitation						
X. ALLOCATION OF WATER RESOURCES						
Droughts						
Conservation				34,000	35,000	69,000

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